

include maintenance instructions that provide specifications for periodic replacement or refurbishment.

(iii) Provide positive pressure and an automatic means to assure that the pressure is relieved at 0.18 psi, or as specified by the manufacturer, above mine atmospheric pressure in the refuge alternative.

(iv) Include warnings to assure that only uncontaminated breathable air is supplied to the refuge alternative.

(v) Include air lines to supply breathable air from the fan or compressor to the refuge alternative.

(A) Air lines shall be capable of preventing or removing water accumulation.

(B) Air lines shall be designed and protected to prevent damage during normal mining operations, a flash fire of 300 °F for 3 seconds, a pressure wave of 15 psi overpressure for 0.2 seconds, and ground failure.

(vi) Assure that harmful or explosive gases, water, and other materials cannot enter the breathable air.

(2) Redundant fans or compressors and power sources shall be provided to permit prompt re-activation of equipment in the event of failure.

(d) Compressed breathable oxygen shall—

(1) Include instructions for deployment and operation;

(2) Provide oxygen at a minimum flow rate of 1.32 cubic feet per hour per person;

(3) Include a means to readily regulate the pressure and volume of the compressed oxygen;

(4) Include an independent regulator as a backup in case of failure; and

(5) Be used only with regulators, piping, and other equipment that is certified and maintained to prevent ignition or combustion.

(e) The applicant shall prepare and submit an analysis or study demonstrating that the breathable air component will not cause an ignition.

(1) The analysis or study shall specifically address oxygen fire hazards and fire hazards from chemicals used for removal of carbon dioxide.

(2) The analysis or study shall identify the means used to prevent any ignition source.

§ 7.507 Air-monitoring components.

(a) Each refuge alternative shall have an air-monitoring component that provides persons inside with the ability to determine the concentrations of carbon dioxide, carbon monoxide, oxygen, and methane, inside and outside the structure, including the airlock.

(b) Refuge alternatives designed for use in mines with a history of harmful gases, other than carbon monoxide, carbon dioxide, and methane, shall be equipped to measure the harmful gases' concentrations.

(c) The air-monitoring component shall be inspected or tested and the test results shall be included in the application.

(d) The air-monitoring component shall meet the following:

(1) The total measurement error, including the cross-sensitivity to other gases, shall not exceed ± 10 percent of the reading, except as specified in the approval.

(2) The measurement error limits shall not be exceeded after start-up, after 8 hours of continuous operation, after 96 hours of storage, and after exposure to atmospheres with a carbon monoxide concentration of 999 ppm (full-scale), a carbon dioxide concentration of 3 percent, and full-scale concentrations of other gases.

(3) Calibration gas values shall be traceable to the National Institute for Standards and Technology (NIST) "Standard Reference Materials" (SRMs).

(4) The analytical accuracy of the calibration gas and span gas values shall be within 2.0 percent of NIST gas standards.

(5) The detectors shall be capable of being kept fully charged and ready for immediate use.

§ 7.508 Harmful gas removal components.

(a) Each refuge alternative shall include means for removing harmful gases.

(1) Purging or other effective procedures shall be provided for the airlock to dilute the carbon monoxide concentration to 25 ppm or less and the methane concentration to 1.0 percent

or less as persons enter, within 20 minutes of persons deploying the refuge alternative.

(2) Chemical scrubbing or other effective procedures shall be provided so that the average carbon dioxide concentration in the occupied structure shall not exceed 1.0 percent over the rated duration, and excursions shall not exceed 2.5 percent.

(i) Carbon dioxide removal components shall be used with breathable air cylinders or oxygen cylinders.

(ii) Carbon dioxide removal components shall remove carbon dioxide at a rate of 1.08 cubic feet per hour per person.

(3) Instructions shall be provided for deployment and operation of the harmful gas removal component.

(b) The harmful gas removal component shall meet the following requirements: Each chemical used for removal of harmful gas shall be—

(1) Contained such that when stored or used it cannot come in contact with persons, and it cannot release airborne particles.

(2) Provided with all materials; parts, such as hangers, racks, and clips; equipment; and instructions necessary for deployment and use.

(3) Stored in an approved container that is conspicuously marked with the manufacturer's instructions for disposal of used chemical.

(c) Each harmful gas removal component shall be tested to determine its ability to remove harmful gases.

(1) The component shall be tested in a refuge alternative structure that is representative of the configuration and maximum volume for which the component is designed.

(i) The test shall include three sampling points located vertically along the centerlines of the length and width of the structure and equally spaced over the horizontal centerline of the height of the structure.

(ii) The structure shall be sealed airtight.

(iii) The operating gas sampling instruments shall be placed inside the structure and continuously exposed to the test atmosphere.

(iv) Sampling instruments shall simultaneously measure the gas con-

centrations at the three sampling points.

(2) For testing the component's ability to remove carbon monoxide, the structure shall be filled with a test gas of either purified synthetic air or purified nitrogen that contains 400 ppm carbon monoxide, ± 5 percent.

(i) After a stable concentration of 400 ppm, ± 5 percent, carbon monoxide has been obtained for 5 minutes at all three sampling points, a timer shall be started and the structure shall be purged or carbon monoxide otherwise removed.

(ii) Carbon monoxide concentration readings from each of the three sampling instruments shall be recorded every 2 minutes.

(iii) The time shall be recorded from the start of harmful gas removal until the readings of the three sampling instruments all indicate a carbon monoxide concentration of 25 ppm or less.

(3) For testing the component's ability to remove carbon dioxide, the carbon dioxide concentration shall not exceed 1.0 percent over the rated duration and excursions shall not exceed 2.5 percent under the following conditions:

(i) At 55 °F (± 4 °F), 1 atmosphere (± 1 percent), and 50 percent (± 5 percent) relative humidity.

(ii) At 55 °F (± 4 °F), 1 atmosphere (± 1 percent), and 100 percent (± 5 percent) relative humidity.

(iii) At 90 °F (± 4 °F), 1 atmosphere (± 1 percent), and 50 percent (± 5 percent) relative humidity.

(iv) At 82 °F (± 4 °F), 1 atmosphere (± 1 percent), and 100 percent (± 5 percent) relative humidity.

(4) Testing shall demonstrate the component's continued ability to remove harmful gases effectively throughout its designated shelf-life, specifically addressing the effects of storage and transportation.

(d) Alternate performance tests may be conducted if the tests provide the same level of assurance of the harmful gas removal component's capability as the tests specified in paragraph (c) of this section. Alternate tests shall be specified in the approval application.

§ 7.509 Approval markings.

(a) Each approved refuge alternative or component shall be identified by a legible, permanent approval marking